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A SPECIALIZATION IN NEST PETIOLE CONSTRUCTION BY QUEENS OF *VESPULA* SPP. (HYMENOPTERA: VESPIDAE)

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Abstract.—Jeanne, Robert L., Department of Entomology, University of Wisconsin, Madison, Wisconsin 53706.—Queens of *Vespula arenaria* and *V. maculata* coat the petiolar suspension of their nests with a rubbery secretion which permits the young comb to move freely within the envelope. The movement allows the queen to squeeze between the comb and the envelope to reach the top of the comb, even though the space enclosed by the envelope is barely larger than the comb it surrounds. Thus the flexible petiole permits the envelope to surround the comb more closely than would be possible were the comb rigidly attached to the substrate. The advantages of minimizing the envelope diameter at this early stage of colony development are unknown, but probably relate to maximization of the numbers and rate of development of the initial brood. When the first workers emerge in the colony, they make the petiole rigid by buttressing it with carton.

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Social wasps in the family Vespidae are collectively known as "paper wasps" because with few exceptions their nests are constructed of a paper-like carton consisting of fibers of wood or other vegetable material collected by the wasps. It has long been known that as the worker wasps masticate each load of carton material prior to adding it to the nest, they mix in a small amount of labial gland secretion, which hardens and serves to cement the fibers together into the more or less paper-like consistency typical of each species (Janet, 1903). The secretion of the adult labial gland probably has this basic function in all of the 30-odd genera of social wasps. In some, however, the secretion has come to play additional more specialized roles in nest construction. In *Polistes*, *Mischocyttarus*, *Belonogaster*, *Parapolybia* and *Ropalidia* (except the subgenus *Icarielia*) it is used in almost pure form to construct the tough petiole that attaches the nest to its substrate (Jeanne, 1970b). *Pseudochartergus fuscatus* and *P. chartergoides* (Jeanne, 1970a) and *Ropalidia opifex* (van der Vecht, 1962) enclose their nests by cementing together surrounding leaves with large amounts of oral secretion that is probably also produced by the labial gland. *Metapolybia pediculata* leaves numerous small "windows" of the pure secretion in the otherwise opaque envelope of its nest (Rau, 1933).

This note reports on a similar specialized use of what is probably also the labial gland secretion in nest construction by *Vespula* (*Dolichovespula*)

arenaria and *V.* (*D.*) *maculata*. The following observations were made on young colonies of these two species in West Chesterfield, New Hampshire, in 1976. Activities of founding queens inside their nests were made visible by cutting away a tangential section of envelope on one side and closing the opening with window glass. Additional nests in early stages of development were collected for study of the petiole structure.

The initial supporting petiole first constructed by the queen in early summer consists of carton and is correspondingly stiff. This condition persists for several days, until after the first few cells are constructed and provided with eggs. As the comb continues to grow in size, however, the queen begins to coat the petiole with a translucent material of rubbery consistency. In one nest of *V. arenaria* the queen was seen to lick the petiole continuously for a period of more than a minute. It is probably this licking that serves to apply the material.

A nest of *V. arenaria* collected on June 15 and containing 25 cells with half-grown larvae in the oldest cells had a thin coating of the substance on its petiole. Nests of both species collected just prior to emergence of the first workers had a much thicker coating; the coating on such a nest of *V. maculata* was approximately 1 mm thick.

At this stage the petiole is rather flat in cross-section, especially near the middle of its length, where the rubbery coating constitutes much more of the cross-sectional area than does the pulp core it surrounds. The flexible nature of the coating combined with the thinness of the core allows the comb to swing freely from side to side and even to twist to a considerable degree. The material is elastic and if the petiole is pulled it will stretch before breaking and sliding off the pulp core.

In a nest of either species shortly prior to emergence of workers the inner layer of envelope closely surrounds the comb, which may now have grown to comprise 30–60 cells. The only way the large queen can squeeze between the comb and the envelope to reach the top of the comb and the petiole is to swing the comb against the envelope on the opposite side like the clapper of a bell, thus widening the space on her side. The queen also pushes the comb to one side to gain access to the comb's peripheral cells, whose openings face somewhat laterally.

Such a specialized suspension of the comb would not be necessary if the space enclosed by the envelope were larger at this stage of nest development. Thus, it appears that the freely mobile comb is an alternative to constructing a larger envelope. There are at least three advantages to minimizing the diameter of the envelope at this stage of colony development: (1) it permits the queen to maximize the proportion of nesting material devoted to brood cells, thus maximizing the number of worker offspring produced early in the life of the colony; (2) it minimizes the volume of air enclosed by the envelope, thus maximizing the effectiveness of

thermoregulation by the queen; (3) it minimizes the outer surface area of the nest through which heat is lost by radiation.

Whatever function the specialization may serve, it is evidently of value only in the queen nest, for within a day after the first workers emerged in one closely-observed nest of *V. arenaria* they began adding carton to the petiole in the form of radiating, sheet-like buttresses. After three days of such activity the attachment of the comb was so stiffened that the queen and workers had difficulty in squeezing by to reach the top of the comb. Meanwhile, however, the inner layers of the envelope were being removed at an accelerating rate by the increasing numbers of workers. This provided a larger crawl space and made continued movement of the comb unnecessary.

While this modification of the petiole was being made by the workers, they were also beginning construction of the petiole for the second comb. The queen took no part in this and there was no evidence that the petiole of this second comb was ever provided with a flexible coating as was that of the first. All combs of mature nests are rigidly attached by enlarged buttressed petioles of stiff carton. Careful removal of this carton reveals the layer of secretion around the central core of the petiole of the first comb, but not of those below.

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